THIS OPINION WAS NOT WRITTEN FOR PUBLICATION

The opinion in support of the decision being entered today (1) was not written for publication in a law journal and (2) is not binding precedent of the Board.

Paper No. 18

UNITED STATES PATENT AND TRADEMARK OFFICE

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BEFORE THE BOARD OF PATENT APPEALS
AND INTERFERENCES

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Ex parte MASAAKI IKEGAMI

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Appeal No. 96-1271
Application 08/190,388[1]

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ON BRIEF

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Before HAIRSTON, KRASS, and BARRETT, Administrative Patent Judges.

KRASS, Administrative Patent Judge.

DECISION ON APPEAL

This is a decision on appeal from the final rejection of claims 1, 3 through 7 and 9 through 11, all of the claims remaining in the application.

[1] Application for patent filed February 2, 1994.

The invention pertains to a semiconductor device including a bipolar transistor. More particularly, a base contact impurity region of the same conductivity type as the base region, but having a higher impurity concentration than the base region, is formed. The base contact impurity region is at a depth shallower than a depth of the emitter impurity region and the base contact impurity region is combined with a metal silicide layer including one metal silicide selected from the group consisting of titanium silicide, hafnium silicide, vanadium silicide, tantalum silicide, molybdenum silicide and tungsten silicide. Forming the higher impurity concentration in the base contact impurity region is said to prevent the increase in the base contact resistance which occurs in conventional semiconductor devices during a silicide reaction. Since the base contact impurity region is of a higher impurity concentration, flow of impurities out of the base contact impurity region during titanium silicide formation, for example, does not result in an impurity concentration in the base contact impurity region of such a low concentration that base contact resistance would increase.

Representative independent claim 1 is reproduced as follows:

1. A semiconductor device, comprising:

a collector impurity region of a first conductivity-type;

a base impurity region of a second conductivity-type having a first impurity concentration formed in a predetermined region on the main surface of said collector impurity region;

an emitter impurity region of the first conductivity-type having a first depth formed in a predetermined region on the main surface of said based [sic, base] impurity region; and

a base contact impurity region of the second conductivity-type having a second impurity concentration higher than said first impurity concentration and a second depth shallower than said first depth formed on the main surface of said based [sic, base] impurity region spaced apart by a predetermined distance from said emitter impurity region, said base contact impurity region having a metal silicide layer formed thereon, said metal silicide layer including one metal silicide selected from the group consisting of $TiSi_x$, $HfSi_x$, VSi_x, $TaSi_x$, $MoSi_x$, and WSi_x.

The examiner relies on the following references:

Lechaton et al. (Lechaton)	4,752,817	Jun. 21, 1988
Welch et al. (Welch)	4,980,738	Dec. 25, 1990

Prior art figs. 28 through 31 and 34

Claims 1, 3 through 7 and 9 through 11 stand rejected under 35 U.S.C. § 103. As evidence of obviousness, the examiner cites Lechaton and Welch with regard to claims 1, 3, 4, 6 and 7, adding prior art Figures 28-31 with regard to claims 9 through 11 and adding prior art Figure 34 to the Lechaton/Welch combination with regard to claim 5.

Reference is made to the briefs and answer for the respective positions of appellant and the examiner.

OPINION

We reverse.

With regard to the independent claims, the examiner applies Lechaton, specifically referring to Figure 4 therein. The semiconductor device of Figure 4 of Lechaton is identified by the examiner as having a collector impurity region 12, a base impurity region 22, an emitter impurity region 30 and a base contact impurity region (annular region) 34, all as claimed. With this much, appellant agrees.

Appellant also agrees with the examiner that while Lechaton discloses a platinum or palladium silicide layer 36,

it does not teach or suggest a metal silicide selected from the group listed in the claims.

The examiner cites Welch which teaches a titanium silicide layer 68 used in a bipolar transistor device. The examiner then concludes that it would have been obvious to use the particular silicide material (i.e., titanium silicide) of Welch in the Lechaton device "since the prior art specifically teaches that such a silicide layer on a heavily doped external base region results in reduced contact resistance" [final rejection-page 2].

It is the examiner's substitution of titanium silicide for the platinum or palladium silicide layer in Lechaton to which appellant vehemently objects. It is appellant's position that there would have been nothing to lead the artisan to make the substitution, all evidence of record appearing to "teach away" from such a substitution. We agree with appellant.

As pointed out by appellant, at page 13 of the principal brief, "titanium silicide and palladium silicide are not mere equivalents which could be readily substituted for each

other." As shown in Publication 1, Table XXI, at page 95, in Exhibit A (as well as the other publications forming part of Exhibit A), attached to the principal brief, when forming titanium silicide, the main diffuser is silicon whereas in forming palladium silicide or platinum silicide, the main diffuser is palladium or platinum. Thus, appellant has established, by objective evidence, that palladium or platinum silicide clearly does not exhibit the same properties as titanium silicide. The examiner has not countered this argument with any objective evidence to the contrary. Accordingly, it is our view that the preponderance of the evidence favors appellant's position of nonobviousness of the instant claimed subject matter.

The examiner takes the position that Lechaton suggests the use of a silicide to provide reduced contact resistance. Yet, the examiner fails to point to anything in Lechaton which would lead to such a suggestion. Furthermore, as pointed out by appellant, at page 4 of the reply brief, and identifying a textbook reference[2] as support thereof, contact resistance is

[2] VLSI Technology, S.M. Sze; McGraw Hill; 1983; Chapter 9, pages 347-350.

determined by more than merely the use of a silicide. Rather, the contact resistance is shown to be proportional to a barrier height at an interface between the metal and the silicon. As pointed out by appellant, at pages 4-5 of the reply brief, since the value of the barrier height varies with the type of material employed, "the contact resistance is not necessarily reduced by using a silicide as alleged by the Examiner."

Moreover, as pointed out by appellant, at page 8 of the reply brief, and as supported by the objective evidence provided by Publication No. (4) attached to the principal brief in Exhibit A, the "snowplow effect" of palladium or platinum silicide appears to stop the movement of implanted impurities (e.g., arsenic). Therefore, since palladium and platinum silicide layers appear to prevent the diffusion of implanted impurities into the metal silicide layer, the impurity concentration at the interface region is not lowered. Thus, unlike the result achieved by the instant claimed invention, the artisan would not have expected the concentration of the impurity region in Lechaton to drop after

or due to the silicide reaction. It is only appellant who teaches the use of specific metal silicides, e.g., titanium silicide, as a layer over a base contact impurity region of such high impurity concentration that the flow of impurities out of the base contact impurity region during the titanium silicide formation does not result in an impurity concentration in the base contact impurity region of such a low concentration that base contact resistance would increase. While titanium silicides, for example, were well known, contrary to the examiner's position, we find no reason that would have led the artisan to employ the titanium silicide layer of Welch in place of the palladium/platinum silicide layer of Lechaton.

We also note that the examiner's attempt, at page 6 of the answer, to somehow discount the specific claim limitation of the particular group of metal silicide layer used, based on the apparent reasoning that the instant claims are product-by-process claims, is not well founded. Quite clearly, the recited metal silicide layer, consisting of a certain group of metal silicides, is a *structural* limitation and cannot be

ignored as a mere process step within a claim otherwise reciting a product.

The examiner's decision rejecting claims 1, 3 through 7 and 9 through 11 under 35 U.S.C. § 103 is reversed.

REVERSED

Kenneth W. Hairston Administrative Patent Judge	)	
Errol A. Krass Administrative Patent Judge	)	BOARD OF PATENT APPEALS AND INTERFERENCES
Lee E. Barrett Administrative Patent Judge	)	

tdc

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